Quantitative assessment of image quality must consider:

- Task
  - Detection, localization, characterization, estimation
- Image properties: multivariate statistics
  - Object statistics
  - Mapping to data space
  - Quantum noise, electronic noise, ...
- Observer
  - Strategy for task performance

Observers

- Ideal observer to assess raw data
  - Many new techniques for computing the ideal observer's performance
- Ideal linear observer as next best thing
- Human observers for processed/displayed images
- Anthropomorphic models
- CAD algorithms

Task considerations & issues

- Methodologies for assessment based on classification and estimation tasks available
- Simplistic tasks can lead to misleading conclusions
- Use realistic tasks to get meaningful results
- ST Goal: Understand when results of "simpler" tasks can be extrapolated
- LT Goal: Relate technical efficacy to diagnostic efficacy to outcomes

Realistic models: objects and images

- Beyond pixel- and voxel-based object models
  - Random shapes
  - Texture, fine scale
  - Dynamic

- More accurate system models
  - Objects are continuous; data are discrete
  - Beyond Fourier (allow nonstationarity, shift-variance...)
  - "Higher-order" physics
    - Scatter, k-escape, turbid media, ...
    - Additional noise sources
    - Effects of limited, discrete data and artifacts

Realistic models of objects and imaging systems will lead to:

- Faster, cheaper, more meaningful system evaluation
  - Ability to evaluate impact of myriad system parameters & patient characteristics
    - Systematic, iterative system optimization
  - Identification of best approaches early
  - Design of clinical trials with greatest impact
- Evaluation of raw data with optimal observer
  - Gives upper bound on system performance
  - Identifies applications where CAD offers greatest advantage
  - No reader variability -- technological differences come through
- Long-term: technology assessment w/o lengthy trials

Research needs - summary

- Realistic models and computational power to
  - "Construct" multiple objects and imaging systems
  - Generate multiple images per system
  - Evaluate statistical properties of the images
  - Compute observer performance
- Generalized ROC-based methodologies
  - Multiple-alternative classification tasks
  - Allowance of random objects
- Shared resources
  - Validated, disseminated software
  - Distributed processing